

WHAT IS CLAIMED IS:

1. A bioptical laser scanning device comprising:

5 a bottom-scanning window substantially orthogonal to a side-scanning window;  
at least one scanning element that cooperates with a plurality of laser beam  
folding mirrors to produce a plurality a horizontal scanning planes that project from  
exterior portions of the side-scanning window at a characteristic propagation direction  
10 whose non-vertical component is greater than thirty-five degrees from normal of the side-  
scanning window.

2. The bioptical laser scanning device of claim 1, wherein said plurality of  
horizontal scanning planes include at least one group of horizontal scanning planes that  
project from the exterior left portion of the side-scanning window and include at least one  
group of horizontal scanning planes that project from the exterior right portion of the  
side-scanning window.

3. A bioptical laser scanning device comprising:

20 a bottom-scanning window substantially orthogonal to a side-scanning window;  
at least one scanning element that cooperates with a plurality of laser beam  
folding mirrors to produce a plurality a vertical scanning planes that project from portions  
25 of the bottom-scanning window proximate to the back of the bottom-scanning window  
and the bottom of the side-scanning window.

30 4. The bioptical laser scanning device of claim 1, wherein the vertical scanning  
planes project from back-left and back-right corners of the bottom-scanning window that  
are proximate to the bottom of the side-scanning window.

5. A bioptical laser scanning device comprising:

a bottom-scanning window substantially orthogonal to a side-scanning window, wherein the bottom-scanning window has four corners;

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at least one scanning element that cooperates with a plurality of laser beam folding mirrors to produce a plurality of vertical scanning planes that project from each one of the four corners of the bottom-scanning window.

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6. A bioptical laser scanning device comprising:

a bottom-scanning window substantially orthogonal to a side-scanning window;

15 at least one scanning element that cooperates with a plurality of laser beam folding mirrors to produce a plurality of groups of vertical scanning planes that project from the bottom-scanning window, wherein said plurality of groups include first and second groups of vertical scanning planes that project from opposing portions of the bottom-scanning window, and said plurality of groups include third and fourth groups of vertical scanning planes, different from said first and second groups, that project from opposing portions of the bottom-scanning window.

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25 7. The bioptical laser scanning device of claim 6, wherein the first and second groups project from the back-left and front-right corners, respectively, of the bottom-scanning window, and wherein the third and fourth groups project from the back-right and front-left corners, respectively, of the bottom-scanning window.

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8. The bioptical laser scanning device of claim 6, wherein the first and second groups of vertical scanning planes are substantially co-planar, and wherein the third and fourth groups of vertical scanning plane are substantially co-planar.

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9. The bioptical laser scanning device of claim 6, wherein the first and second groups of vertical scanning planes are substantially orthogonal to the third and fourth groups of scanning planes.

5 10. A bioptical laser scanning device comprising:

a bottom-scanning window substantially orthogonal to a side-scanning window;

10 at least one scanning element that cooperates with a plurality of groups of laser beam folding mirrors to produce a plurality of vertical scanning planes projecting from the bottom-scanning window that are capable of reading bar-code symbols on the bottom surface and all four sides of a four-sided article.

11. A laser scanning device comprising

15 at least one window; and

20 at least one laser beam production module that cooperates with a rotating polygonal mirror and a plurality of laser beam folding mirrors to produce a plurality of scanning planes that project through the window, wherein the incidence angle of the laser beam produced by the laser beam production module is offset with respect to the axis of rotation of the rotating polygonal mirror.

25 30 12. The laser scanning device of claim 11, further comprising a plurality of laser beam production modules that cooperate with the rotating polygonal mirror and the plurality of laser beam folding mirrors to produce a plurality of scanning planes that project through the window, wherein the incidence angle of the laser beam produced by each laser beam production module is offset with respect to the axis of rotation of the rotating polygonal mirror to produce overlapping scanning ray patterns that are incident on at least one common mirror to provide a dense scanning pattern projecting therefrom.

13. The laser scanning device of claim 12, wherein the window comprises one of a bottom-scanning window and a side-scanning window of a bioptical laser scanner.

5 14. The laser scanning device of claim 13, wherein the common mirror redirects the dense scanning pattern incident thereon to form a plurality of horizontal scan planes that project from the front side of the bottom-scanning window diagonally upward toward the side-scanning window.

10 15. A bioptical laser scanning device comprising:  
a bottom-scanning window substantially orthogonal to a side-scanning window;  
at least one scanning element that cooperates with a plurality of laser beam folding mirrors to produce at least eight different vertical scanning planes that project from the side-scanning window.

16. The bioptical laser scanning device of claim 15, wherein the side-scanning window with a square area less than 37,500 sq. mm.

20 17. A bioptical laser scanning device comprising:  
a bottom-scanning window substantially orthogonal to a side-scanning window;  
at least one scanning element that cooperates with a plurality of laser beam folding mirrors to produce at least 13 different horizontal scanning planes that project from the side-scanning window.

25 18. The bioptical laser scanning device of claim 17, wherein the at least one scanning element cooperates with said plurality of laser beam folding mirrors to produce at least 20 different horizontal scanning planes that project from the side-scanning window.

19. The bioptical laser scanning device of claim 17, wherein the side-scanning window with a square area less than 37,500 sq. mm.

20. A bioptical laser scanning device comprising:  
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a bottom-scanning window substantially orthogonal to a side-scanning window;  
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at least one scanning element that cooperates with a plurality of laser beam folding mirrors to produce at least 21 different scanning planes that project from the side-scanning window.

21. The bioptical laser scanning device of claim 20, wherein the at least one scanning element cooperates with said plurality of laser beam folding mirrors to produce at least 28 different scanning planes that project from the side-scanning window.

22. The bioptical laser scanning device of claim 20, wherein the side-scanning window with a square area less than 37,500 sq. mm.

23. A bioptical laser scanning device comprising:  
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a bottom-scanning window substantially orthogonal to a side-scanning window;  
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at least one scanning element that cooperates with a plurality of laser beam folding mirrors to produce at least seven different vertical scanning planes that project from the bottom-scanning window.

24. The bioptical laser scanning device of claim 23, wherein the bottom-scanning window with a square area less than 15,000 sq. mm

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25. A bioptical laser scanning device comprising:

a bottom-scanning window substantially orthogonal to a side-scanning window;  
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at least one scanning element that cooperates with a plurality of laser beam  
folding mirrors to produce at least 21 different horizontal scanning planes that project  
from the bottom-scanning window.

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26. The bioptical laser scanning device of claim 25, wherein the at least one scanning  
element cooperates with said plurality of laser beam folding mirrors to produce at least 24  
different horizontal scanning planes that project from the bottom-scanning window.

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27. The bioptical laser scanning device of claim 25, wherein the bottom-scanning  
window with a square area less than 15,000 sq. mm.

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28. A bioptical laser scanning device comprising:

a bottom-scanning window substantially orthogonal to a side-scanning window;  
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at least one scanning element that cooperates with a plurality of laser beam  
folding mirrors to produce at least 25 different scanning planes that project from the  
bottom- scanning window.

29. The bioptical laser scanning device of claim 28, wherein the at least one scanning  
element cooperates with said plurality of laser beam folding mirrors to produce at least 40  
different scanning planes that project from the bottom-scanning window.

30. The bioptical laser scanning device of claim 28, wherein the bottom-scanning  
window with a square area less than 15,000 sq. mm.